

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
601.21 Gabions, Galvanized	cubic meter [Cubic Yard]
601.211 Gabions, Galvanized and Hand Filled	cubic meter [Cubic Yard]
601.22 Gabions, PVC Coated	cubic meter [Cubic Yard]
601.221 Gabions, PVC Coated and Hand Filled Yard]	cubic meter [Cubic
601.23 Mattresses, Galvanized: _____	cubic meter [Cubic Yard]
601.24 Mattresses, PVC Coated: _____	cubic meter [Cubic Yard]

## SECTION 602 - PIPE LINING

Reserved

## SECTION 603 - PIPE CULVERTS AND STORM DRAINS

603.01 Description This work shall consist of constructing or reconstructing pipe culverts and storm drains, in accordance with these specifications, the Standard Detail plans and in reasonably close conformity with the lines and grades shown on the plans or established.

The word "pipe" in these specifications shall include both round pipe and pipe arches..

603.02 Materials Meet Sections:

Joint Mortar	705.02
Flexible Gaskets	705.03
Flexible Culvert Polyvinylchloride (PVC) Pipe	706.08
Corrugated Steel, Metallic Coated Pipe	707.02
Fiber-bonded Corrugated Steel Pipe & Pipe Arches	707.04
Corrugated Aluminum Alloy Pipe & Pipe Arches	707.06
Polymer Precoated, Galvanized Corrugated Steel	707.07

## Pipe &amp; Pipe Arches

Aluminum Coated (Type 2) Corrugated Steel Pipe	707.10
Zinc-Coated (Galvanized) Corrugated Steel Pipe	707.11

## Rigid Culvert

Reinforced Concrete Pipe	706.02
Corrugated Polyethylene Pipe	706.06

Flexible culverts with a diameter of 1200 mm [48 in] or more shall have the ends cut to a partial bevel as called for on the plans. The cut ends of galvanized steel pipe shall be regalvanized or painted with a zinc aluminum paint conforming to Federal Specification TT-P-1561A or an approved equal.

Helical corrugated pipe shall be re-rolled to form angular corrugations on the ends.

The corrugated bands for connecting pipe with 68 mm by 13 mm [ $2\frac{2}{3}$  in by  $\frac{1}{2}$  in] corrugations shall be not less than 265 mm [ $10\frac{1}{2}$  in] wide.

Rigid culverts, designated to have the ends shaped to a partial bevel, shall be either cast or cut to the required shape and dimensions. In either case, the edges of the pipe shall be even and true with no exposed reinforcing.

603.03 Construction Requirements

- 603.031 General Culvert pipe and pipe arches shall be furnished under the following options unless otherwise specified.

Option I The Contractor shall furnish any of the following type of pipe under Option I:

- Corrugated Steel, Metallic (zinc or aluminum) Coated Pipe
- Reinforced Concrete Pipe
- Corrugated Polyethylene Pipe
- Any of the metal pipes allowed under Option III.

Option III The Contractor shall furnish any of the following types of pipe under Option III. (Corrugated pipe used under this option shall be adequate to equal the flow capacity of comparable smoothlined pipe):

- Fiber-bonded Corrugated Steel Pipe
- Corrugated Aluminum Alloy Pipe
- Polyvinylchloride (PVC) Pipe
- Polymer-Precoated Galvanized Corrugated Steel Pipe
- Reinforced Concrete Pipe
- Corrugated Polyethylene Pipe

Within any single run of culvert pipe, including extensions of existing culverts, the type of pipe shall be the same unless otherwise specified or as directed by the Engineer. In a closed drainage system, a run of culvert pipe shall be considered from catch basin to catch basin. In an open drainage system, a run of culvert shall be considered from inlet to outlet.

Option III polyvinylchloride (PVC) pipe shall only be used in closed drainage systems, between catch basins.

603.0311 Corrugated Polyethylene Pipe for Option III If inspection by the Resident reveals an unsatisfactory installation, the Resident may direct the contractor to test installed Smooth Lined Corrugated Polyethylene Pipe for Option III to ensure the vertical deflection does not exceed the maximum allowable deflection. Maximum allowable deflection shall be 5 percent of the sum of the nominal inside diameter minus a 1.5 percent undersize tolerance.

Deflection tests shall not be performed until at least 30 days after completion of installation and compaction of backfill. The pipe shall be cleaned and inspected for offsets and obstructions before testing.

For all pipes 600 mm [24 in] and smaller, a mandrel shall be pulled through the pipe by hand to ensure the maximum allowable deflections have not been exceeded. The mandrel shall be certified by the Department prior to use. If the mandrel fails to pass through the pipe, the pipe will be deemed overdeflected.

For pipes greater than 600 mm [24 in], deflections shall be determined by a method

submitted and approved by the Department. If a mandrel is selected, the minimum diameter and length and other requirements shall conform to the dimensions and requirements stated below. If other methods are used the measurements shall meet the minimum mandrel diameter requirements.

Any overdeflected pipe shall be uncovered and if not damaged as determined by the Department shall be allowed for reinstallation. Damaged pipe shall not be reinstalled and shall be removed from the work site.

The mandrel shall be a rigid non-adjustable, odd numbered-leg (9 legs minimum) mandrel having an effective length not less than its nominal diameter and having a minimum diameter at any point along the full length as follows:

Nominal Size	Minimum Mandrel Diameter
mm [in]	mm [in]
300 [12]	285 [11.23]
375 [15]	356 [14.02]
450 [18]	428 [16.84]
600 [24]	570 [22.46]
750 [30]	713 [28.07]
900 [36]	856 [33.69]
1050 [42]	998 [39.30]
1200 [48]	1141 [44.92]

When deflection testing reveals overdeflected pipe, all costs incurred by the Contractor including mandrel and deflection testing, reinstallation of pipe and delays shall be the responsibility of the Contractor. When deflection testing reveals satisfactory pipe, all costs for deflection testing will be paid for by the Department.

603.032 Excavation Trenches shall be excavated in accordance with the requirements of Section 206 - Structural Excavation and wide enough to allow joining the culvert and compacting the bedding and backfill material under and around the culvert. Unless otherwise designated, trench walls shall be as nearly vertical as possible and the trench width no greater than necessary for installation of the culvert.

603.04 Bedding Culverts, less than 1050 mm [42 in] in diameter, shall be bedded on

a firm foundation of uniform density. After placing the culvert pipe, backfill material shall be placed along the bottom of the trench, thoroughly tamped against the lower portion of the pipe with special care taken not to move the bedded pipe.

For culverts 1050 mm [42 in] in diameter and larger, the bottom of the trench shall be compacted to uniform density and shaped to fit a template with reasonable closeness for at least 10 percent of the culvert's total height.

On all bedding, when bell and spigot pipe is used, the portion of trench at the joints shall be shaped to fit the bell.

603.05 Laying Culvert The Contractor shall not install nor backfill culverts between December 15<sup>th</sup> and April 1<sup>st</sup> without written permission. Installing shall begin at the downstream end of the culvert line. Bell or groove ends of rigid culverts shall be placed facing upstream.

Elliptically shaped culverts shall be placed with the major axis within 5 degrees of vertical. Elliptically reinforced concrete pipe shall be placed with the vertical axis, indicated by the manufacturer, within 5 degrees of vertical.

603.06 Joining Culverts The method of joining rigid culvert sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even. Joints shall be made with portland cement mortar, portland cement grout, rubber ring gaskets, or flexible plastic gaskets.

The pipe ends shall be thoroughly cleaned before the joint is made. Mortared joints shall be made with an excess of mortar to form a bead around the outside of the culvert and finished smooth inside. For grouted joints, molds or runners shall be used to retain the poured grout.

Joints with rubber ring gasket or flexible plastic gasket shall be made in accordance with the manufacturer's recommended procedures.

When portland cement mixtures are used, the completed joints shall be covered to protect against drying.

Flexible culvert section and metal end sections shall be firmly jointed by coupling

bands. These bands shall meet the same applicable requirements as the flexible culvert being joined.

**603.07 Shop Strutting** All flexible circular culvert pipe 1200 mm [48 in] in diameter and larger shall be elongated along the vertical diameter in accordance with one of the following two methods:

a) The pipe shall be elongated by the manufacturer after fabrication by increasing the diameter along the vertical axis approximately 3 percent with a corresponding decrease along the horizontal axis. The elongation shall be obtained by installing rods and tightening the rods, uniformly from end to end of the pipe, obtaining approximately one quarter of the required elongation each time throughout the length of the pipe.

The rods shall be 16 mm [ $\bullet$  in] diameter threaded 180 mm [7 in] at both ends with washers and nuts. The length of the rods shall be the diameter of the pipe plus 200 mm [8 in]. The rods shall be placed on the horizontal axis of the pipe at 600 mm [2 ft] spacing and located halfway between the circumferential riveting. A block of soft wood 50 mm by 100 mm by 300 mm long [2 in by 4 in by 12 in long], shall be placed over the rods at each end to provide contact against the outside of the pipe. The long dimension of the blocks shall be parallel with the horizontal axis of the pipe. The rods shall be left in the pipe until the fill is completed and compacted, unless for some unusual condition their removal is ordered. The rods shall be removed by cutting from the inside adjacent to the pipe.

(b) The pipe shall be elongated by the manufacturer by increasing the diameter along the vertical axis approximately 5 percent with a corresponding decrease along the horizontal axis by applying sufficient pressure to the sides of the pipe after fabrication to produce the specified distortion. The elongation shall be maintained by drilling holes in the ends of the pipe sections and placing and tightening horizontal wires. After the pipe sections have been installed with coupling bands, the wires shall be removed.

Helically corrugated culvert sections shall be match marked before being elongated by the manufacturer or before the 16 mm [ $\bullet$  in] diameter rods are installed.

**603.08 Backfilling Culverts and Storm Drains** After the pipe is installed, it will be

inspected before any backfill material is placed. All pipe found to be out of alignment, unduly settled or damaged to the extent that full performance is impaired, shall be taken up and re-laid or replaced.

Trenches shall be backfilled in accordance with Section 206.03 and as follows. The backfill material shall be thoroughly rammed under the haunches of the pipe with power or pneumatic operated hand tampers. The remainder of the backfill shall be thoroughly compacted with power tampers or vibratory compactors or other approved equipment or combination of equipment.

When the top of the pipe is exposed above the top of the trench, the embankment material around the pipe shall be placed and compacted on each side of the pipe in the aforementioned manner described for backfilling trenches, for a width of 1.5 m [5 ft] measured from the outside diameter of the pipe. Only that portion of the embankment on each side and top of the pipe, for a minimum distance of 375 mm [15 in] measured from the outside diameter of the pipe, must be of material conforming to the requirements described for backfilling in Section 206.03. Backfill material beyond these limits may contain stones larger than 75 mm [3 in] but no greater than the thickness of the layer being placed. The embankment construction around the pipe shall continue up to an elevation 375 mm [15 in] above the top of the pipe. Beyond these limits, the embankment shall be placed and compacted in accordance with the embankment construction requirements specified for the work except where the induced trench method is called for on the plans.

When construction equipment is used or traffic is maintained the Contractor shall provide a minimum cover of 1 m [3 ft] over all pipes, if possible. Whenever this cover extends above the subgrade the Contractor shall temporarily place earth, which shall be removed when necessary to complete the work in accordance with the plans, or as directed. Any deviation from this practice shall have prior approval.

603.09 Induced Trench Under this method, for designated rigid pipes only, the embankment shall be completed as specified above, to a height above the culvert equal to the vertical outside diameter of the pipe plus 300 mm [1 ft]. A trench, equal in width to the outside horizontal diameter of the pipe, shall then be excavated to within 300 mm [1 ft] of the top of the pipe. Trench walls shall be as nearly vertical as possible. Hay bales shall be used to fill the lower 1/4 to 1/3 of the trench. Construction of the embankment above shall then proceed in a normal manner. The trench shall be loosely filled with

highly compressible soil.

603.10 Removing and Relaying Culverts The pipe shall be carefully removed from its existing location, transported to and installed in the new location in accordance with these specifications for the particular type of pipe involved. Pipe damaged by the Contractor shall be replaced with pipe of similar type by the Contractor without additional compensation.

New metal bands or joint material shall be supplied and installed when necessary.

603.11 Method of Measurement Culvert and storm drain pipe of the different types and sizes, both new and re-laid, will be measured by the length in meter [linear foot] along the invert, laid as directed, complete in place, and accepted. Pipe laid in excess of the authorized length will not be included.

When the ends of a pipe are sloped or skewed, the amount to be included for payment shall be the length along the invert of the pipe.

When elbows, tees, wyes, or other special fittings are required, each fitting shall be included for payment as 1 additional meter [3 additional linear feet] of the largest pipeline involved.

Inlet grate units will be measured by each unit installed, complete in place, and accepted.

603.12 Basis of Payment The accepted quantities of pipe for culverts and storm drains will be paid for at the contract unit price per meter [linear foot], for the types and sizes specified, complete in place.

No payment will be made for pipe ordered without written approval of the Resident when such pipe is not required to be installed for completion of the work.

Excavation for culverts and storm drains, including excavation below the pipe, for induced trench and for bedding and backfilling will be measured and paid for as provided in Section 206 - Structural Excavation.

Whenever minimum cover material extends above the subgrade, removal of the cover



material necessary to complete the work will not be paid for directly but shall be considered part of the work specified herein.

Coupling bands and joint material will not be paid for separately but shall be considered included in the unit bid price for the type of pipe being used or re-laid.

Existing culverts to be re-laid, salvaged, or wasted shall be removed and disposed of as directed. The excavation for removal of these culverts that is not paid for under other items or incidental to other items shall be paid for as Common Excavation.

Inlet grate units will be paid for at the contract unit price each for the size specified, complete in place.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
603.15 300 mm [12 in] Culvert Pipe Option I	meter [Linear Foot]
603.16 375 mm [15 in] Culvert Pipe Option I	meter [Linear Foot]
603.17 450 mm [18 in] Culvert Pipe Option I	meter [Linear Foot]
603.18 525 mm [21 in] Culvert Pipe Option I	meter [Linear Foot]
603.19 600 mm [24 in] Culvert Pipe Option I	meter [Linear Foot]
603.20 750 mm [30 in] Culvert Pipe Option I	meter [Linear Foot]
603.21 900 mm [36 in] Culvert Pipe Option I	meter [Linear Foot]
603.159 300 mm [12 in] Culvert Pipe Option III Foot]	meter [Linear
603.169 375 mm [15 in] Culvert Pipe Option III	meter [Linear Foot]
603.179 450 mm [18 in] Culvert Pipe Option III	meter [Linear Foot]
603.189 525 mm [21 in] Culvert Pipe Option III	meter [Linear Foot]
603.199 600 mm [24 in] Culvert Pipe Option III	meter [Linear Foot]
603.2009 675 mm [27 in] Culvert Pipe Option III	meter [Linear Foot]
603.209 750 mm [30 in] Culvert Pipe Option III	meter [Linear Foot]
603.2019 825 mm [33 in] Culvert Pipe Option III	meter [Linear Foot]
603.219 900 mm [36 in] Culvert Pipe Option III	meter [Linear Foot]
603.229 1050 mm [42 in] Culvert Pipe Option III	meter [Linear Foot]
603.239 1200 mm [48 in] Culvert Pipe Option III	meter [Linear Foot]
603.249 1350 mm [54 in] Culvert Pipe Option III	meter [Linear Foot]

603.259	1500 mm [60 in] Culvert Pipe Option III	meter [Linear Foot]
603.269	1650 mm [66 in] Culvert Pipe Option III	meter [Linear Foot]
603.279	1800 mm [72 in] Culvert Pipe Option III	meter [Linear Foot]
603.289	2100 mm [84 in] Culvert Pipe Option III	meter [Linear Foot]
603.30	525 mm [21 in] span 375 mm [15 in] rise Pipe Arch Option III	meter [Linear Foot]
603.31	600 mm [24 in] span 450 mm [18 in] rise Pipe Arch Option III	meter [Linear Foot]
603.32	700 mm [28 in] span 500 mm [20 in] rise Pipe Arch Option III	meter [Linear Foot]
603.33	875 mm [35 in] span 600 mm [24 in] rise Pipe Arch Option III	meter [Linear Foot]
603.34	1050 mm [42 in] span 725 mm [29 in] rise Pipe Arch Option III	meter [Linear Foot]
603.35	1225 mm [49 in] span 825 mm [33 in] rise Pipe Arch Option III	meter [Linear
	Foot]	
603.36	1425 mm [57 in] span 950 mm [38 in] rise Pipe Arch Option III	meter [Linear Foot]
603.37	1600 mm [64 in] span 1075 mm [43 in] rise Pipe Arch Option III	meter [Linear
	Foot]	
603.38	1650 mm [66 in] span 1275 mm [51 in] rise Pipe Arch Option III	meter [Linear Foot]
603.39	1825 mm [73 in] span 1375 mm [55 in] rise Pipe Arch Option III	meter [Linear Foot]
603.40	2025 mm [81 in] span 1475 mm [59 in] rise Pipe Arch Option III	meter [Linear Foot]
603.41	610 mm [24 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]
603.42	762 mm [30 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]
603.43	914 mm [36 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]
603.44	1067 mm [42 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]
603.45	1219 mm [48 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]
603.46	1372 mm [54 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]
603.47	1524 mm [60 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]
603.48	1676 mm [66 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]
603.49	1829 mm [72 in] Reinforced Conc. Pipe Class IV	meter [Linear Foot]

603.73	Remove and Relay Metal Pipe:	meter [Linear Foot]
603.7315	Remove and Relay 375 mm [15 in] Metal Pipe:	meter [Linear Foot]
603.7318	Remove and Relay 450 mm [18 in] Metal Pipe:	meter [Linear Foot]
603.7324	Remove and Relay 600 mm [24 in] Metal Pipe:	meter [Linear Foot]
603.733	Remove and Relay 750 mm [30 in] Metal Pipe:	meter [Linear Foot]
603.7336	Remove and Relay 900 mm [36 in] Metal Pipe:	meter [Linear Foot]
603.7348	Remove and Relay 1200 mm [48 in] Metal Pipe:	meter [Linear Foot]
603.7372	Remove and Relay 1800 mm [72 in] Metal Pipe:	meter [Linear Foot]
603.74	Remove and Relay Concrete Pipe:	meter [Linear Foot]
603.7415	Remove and Relay 375 mm [15 in] Concrete Pipe:	meter [Linear
	Foot]	
603.7418	Remove and Relay 450 mm [18 in] Concrete Pipe:	meter [Linear
	Foot]	
603.7421	Remove and Relay 525 mm [21 in] Concrete Pipe:	meter [Linear
	Foot]	
603.7424	Remove and Relay 600 mm [24 in] Concrete Pipe:	meter [Linear
	Foot]	
603.743	Remove and Relay 750 mm [30 in] Concrete Pipe:	meter [Linear
	Foot]	
603.7436	Remove and Relay 900 mm [36 in] Concrete Pipe:	meter [Linear
	Foot]	
603.7442	Remove and Relay 1050 mm [42 in] Concrete Pipe:	meter [Linear
	Foot]	
603.7448	Remove and Relay 1200 mm [48 in] Concrete Pipe:	meter [Linear
	Foot]	
603.7454	Remove and Relay 1350 mm [54 in] Concrete Pipe:	meter [Linear
	Foot]	
603.746	Remove and Relay 1500 mm [60 in] Concrete Pipe:	meter [Linear
	Foot]	
603.7472	Remove and Relay 1800 mm [72 in] Concrete Pipe:	meter [Linear
	Foot]	
603.75	150 mm [6 in] Inlet Grate Unit	Each
603.76	300 mm [12 in] Inlet Grate Unit	Each
603.77	375 mm [15 in] Inlet Grate Unit	Each
603.78	450 mm [18 in] Inlet Grate Unit	Each
603.79	525 mm [21 in] Inlet Grate Unit	Each
603.80	600 mm [24 in] Inlet Grate Unit	Each

603.81	750 mm [30 in] Inlet Grate Unit	Each
603.82	900 mm [36 in] Inlet Grate Unit	Each

## SECTION 604 - MANHOLES, INLETS, AND CATCH BASINS

604.01 Description Construct manholes, inlets, and catch basins.

604.02 Materials Materials shall meet the requirements specified in the following Sections of Division 700 - Materials:

Portland Cement	701.01
Clay or Shale Brick	704.01
Concrete Masonry Blocks	704.03
Joint Mortar	705.02
Reinforcing Steel	709.01
Stone Curbing and Edging	712.04
Precast Concrete Units	712.06

Except as otherwise provided on the plans, concrete for these structures shall meet the requirements of Section 502 - Structural Concrete.

Catch basin grates shall be either the type of grate shown on the Standard Details or an approved equal. The corners shall be notched by the Contractor at the project site by grinding the corner to fit the cast iron frames.

604.03 Construction Requirements Concrete catch basins and manholes shall be constructed of precast units, except that concrete blocks may be used around inlet and outlet pipes. Joints for precast concrete units shall be of portland cement mortar, rubber gaskets, flexible plastic rings, mastic joint filler or other approved types to form a watertight joint. Joints for concrete blocks shall be of portland cement mortar, not more than 12 mm [ $\frac{1}{2}$  in] wide, completely filled and neatly tooled on the inside of the structure.

Metal catch basins shall be corrugated metal pipe units mounted on a portland cement concrete foundation.